Development of offline ion source for collinear laser spectroscopy of RI beams

M. Tajima,[*1] A. Takamine,[*1] T. Asakawa,[*2] M. Wada,[*3] Y. Sasaki,[*2] Y. Nakamura,[*4] H. Iimura,[*5,*1] K. Okada,[*6] T. Sonoda,[*1] H. A. Schuessler,[*7,*1] H. Odashima,[*4] Y. Matsuo,[*2,*1] and H. Ueno[*1]

Collinear laser spectroscopy of RI beams is a powerful probe to directly measure the nuclear properties of ground or isomeric states. We designed and constructed an offline ion source for the planned optical spectroscopy of RI ion beams of refractory elements at a rate of 100 pps. Because it is difficult to obtain ions of refractory elements by the widely-used surface ionization method, we adopted laser ablation of a solid target in He gas and the RF ion guide system[1] for ion beams with low emittance.

Figure 1(a) shows a sketch of the setup. The RF ion guide system is composed of cylindrical DC electrodes, RF carpet (RFCP), a quadrupole ion guide (QPIG), and RFQ. There are 54 electrodes and an exit hole at the center of RFCP. QPIG is composed of 4 thin plates with 28 electrodes on each plate assembled as an azimuthally four-segmented square tube. RFQ is composed of three segments of four SUS rods and an endcap. A solid target for laser ablation is fixed on the surface of the cylindrical electrode. An aluminosilicate Cs^+ emitter is also prepared for the performance test. Helium gas is introduced constantly and the typical pressure is approximately 22 mbar at the most upstream chamber. This ion source system is floated at 10 kV and connected to a test beamline through an insulation flange as shown in Fig. 1(b).

The target is irradiated by an Nd:YAG laser pulse (532 nm, 10 ns width). First, the produced energetic ions are stopped via collisions with He gas and guided to RFCP by a DC electric field. Then, the ions are subsequently guided to the downstream by RFCP, QPIG, and RFQ with applied RF and DC electric fields. After the ions are focused through the Einzel lens and four quadrupoles, they are separated depending on m/q using a dipole magnet and collected onto a Faraday cup (FC). Figures 1(c)–(e) show the relative beam intensity as a function of the applied RF amplitudes for RFCP, QPIG, and RFQ, respectively, when Ag metal target was used for laser ablation and the Cs^+ emitter was used as a reference. Typical beam intensity at FC is 10^7–10^8 ions per laser pulse, which is sufficient for the demonstration of the planned spectroscopy of RI beams.

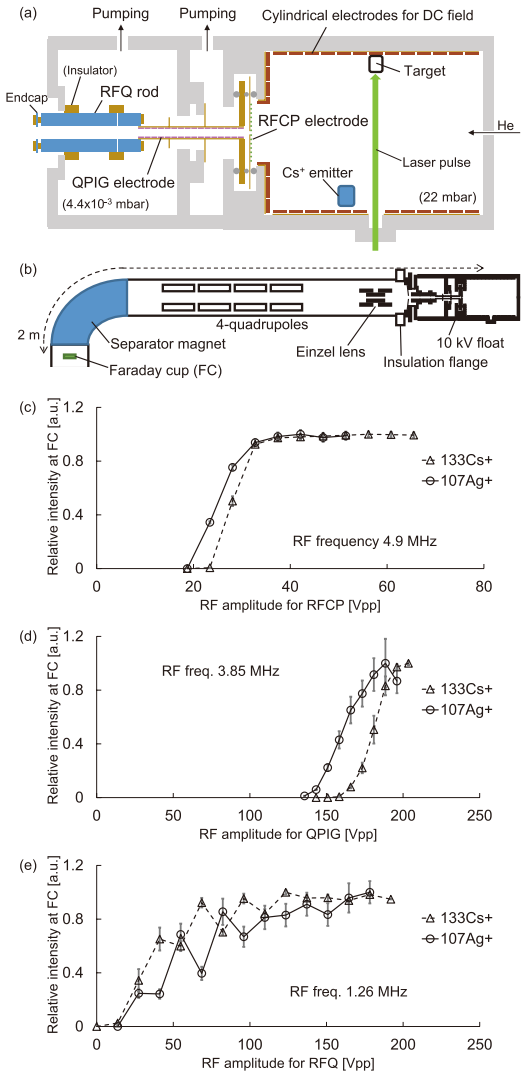

Fig. 1. Sketch of the ion-source system (a) and test beamline (b). Dependence of beam intensity at the Faraday cup as a function of applied RF amplitude for RFCP (c), QPIG (d), and RFQ (e).

As the next step, laser ablation for different targets such as BaF_2 and Zr will be conducted. In addition, we will work toward the development of on-line spectroscopy for low-intensity beams with coincidence method.[2]

*1 RIKEN Nishina Center
*2 Department of Advanced Sciences, Hosei University
*3 Wako Nuclear Science Center, KEK
*4 Department of Physics, Meiji University
*5 Nuclear Science and Engineering Research Center, JAEA
*6 Department of Physics, Sophia University
*7 Department of Physics and Astronomy, Texas A&M University

References

1) M. Wada *et al.*, Nucl. Instrum. Methods Phys. Res. B **204**, 570 (2003).
2) D. A. Eastham *et al.*, Opt. Commun. **82**, 23 (1991).